Space Weather Technical Forecast

Issued on Saturday, 08 January 2022 at 12:34 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of G1/Minor Storm over the UTC weekend. Increasing Slight Chance of M-class flares (R1-R2 radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the past 24 hours, with peak X-ray activity recorded at GOES 16 being an isolated C2.7 class flare at 07/2210UTC from AR2924. There are currently two numbered sunspot regions on the visible disc: the larger being AR2924, which is nearing the solar meridian as a Ehi/Beta; and finally a southeast quadrant Hax/Alpha in the form of AR2925. The trend in both these regions was towards consolidation, albeit with slight areal growth. AR2924 saw some proliferation of intermediate spots in the first half of the period, however this behaviour waned as the UTC day progressed. In addition to these confirmed regions, the eastern solar horizon is bright in EUV flux in both hemispheres, likely indicating some returning spots, although these have yet to present for analysis.

No Earth-directed Coronal Mass Ejections (CMEs) have been observed in currently available imagery. Spells of bright flux emanating from a possible small filament leading 2924 on the disc were seen in the period, peaking 08/0600UTC, however these do not appear to have resulted in any CME. A high latitude CME visible in STEREO and Lasco coronagraphs in the period has been determined to be far-sided.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR and ACE at L1 were indicative of a slow regime, possibly evolving into a CIR (Co-rotating Interacting Region), with this likely to be that preceding any entry into expected coronal hole 43. The phi angle transitioned from positive (away from the sun) prior to 08/0700UTC to become more variable thereafter, perhaps the start of the necessary sector change before CH43's arrival.

The solar wind speed trace was somewhat noisy given the low numbers of particles recorded at L1, however it displayed a largely flat trend near 300km/s, The solar wind density was initially at normal background levels around mid-single figures ppcc, however this climbed during the UTC morning to reach a peak near 30ppcc in the suggested CIR. The IMF was mostly within its typical slow regime range, but showed a slight late peak to 6nT, with the north-south component varying between +/-4nT.

The net result of the above solar wind measures was Quiet geomagnetic activity throughout, with a provisional peak Kp of 1- in the 06-09UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels throughout.

High energy electron flux (greater than 2MeV) ranged between Normal Background and Moderate flux, peaking with the diurnal cycle at 849pfu at 08/1115UTC. Electron fluence remained below the Active threshold (1e8 integrated pfu) on a steady trend, with 3.97e7 integrated pfu recorded at 08/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

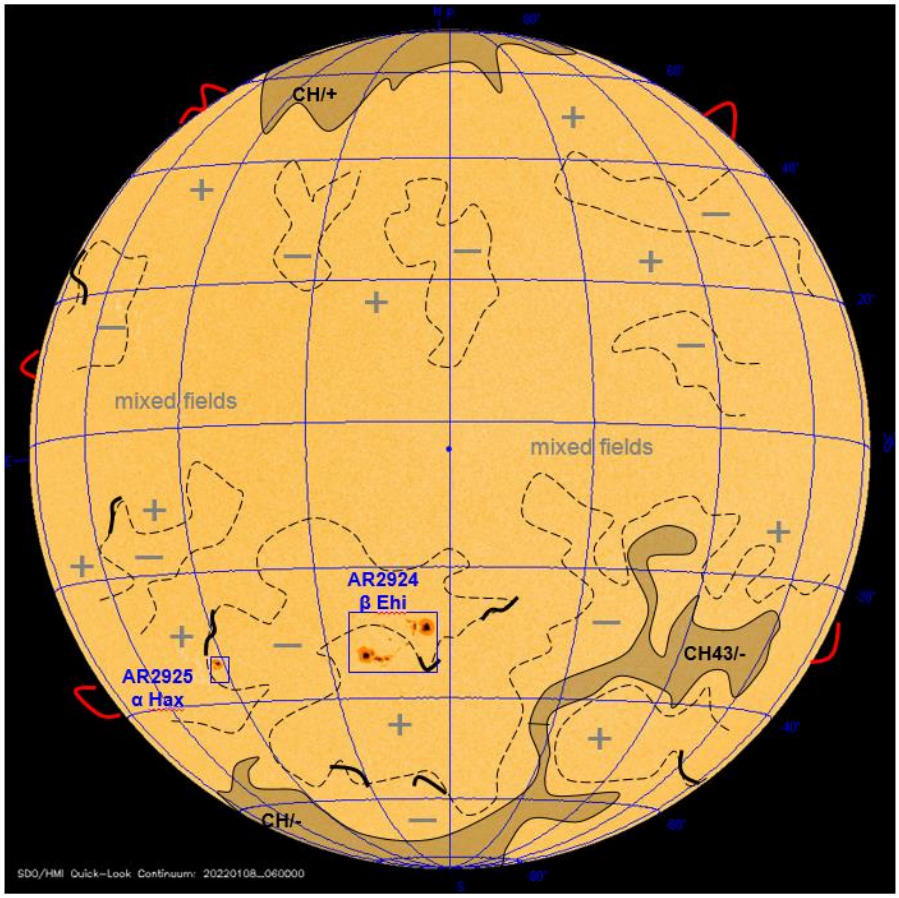
Solar Activity: Solar activity is expected to remain Low, with further C-class flares possible. In addition, there is an increasing daily Slight Chance of M-class flares, as numerous large returning regions are expected to rotate onto the visible disc over the UTC weekend.

Solar Wind / Geomagnetic Activity: There are currently no Earth-directed CMEs that feature in the forecast, and just one non-recurrent coronal hole, CH43. Quiet geomagnetic activity is expected at first, soon increasing to Unsettled, with a Slight Chance of G1/Minor Storms later on Day 1 into Day 2 (Sunday 09 January). Activity is currently expected to return back to Quiet again from Day 3 (Monday 10 January).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, albeit with a very slight increase in risk with the westward progression if the current front-sided sunspots.

The high energy electron flux oscillation (greater than 2MeV) may show an eventual slight increase in magnitude in the wake of the expected high speed stream from CH43, with a resultant Chance of Active fluence by the end of the four-day period after any initial apparent suppression.

Figure 1. Solar Analysis Valid 08/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in this forecast period.

The sole forecast feature in the geomagnetic forecast is therefore a non-recurrent coronal hole: CH43/- in the southern solar hemisphere. Because of its novel status, confidence is only moderate on its timing and strength, with STEREO A suggesting 400-450km/s in around 36 hours' time from the issue of this document. This is felt to perhaps be both tardy and underdone in terms of peak speeds - probably a result of the satellite sampling a higher solar latitude than Earth (0.5 North, versus Earth's 4.0 degrees South). The most likely wind speeds are considered to be elevated at around 500km/s, with some signs from the current increasing solar wind density at DSCOVR that the CIR leading this hole may already have arrived - the phi angle is also vacillating which also implies a sector crossing to the required negative (towards the sun) may be imminent.

Quiet geomagnetic activity is expected at first, increasing to Unsettled to Active with a Slight Chance of G1/Minor Storms for a 24 to 36 hour period after we connect to CH43. Activity is currently expected to return back to Quiet again from Day 3 (Monday 10 January).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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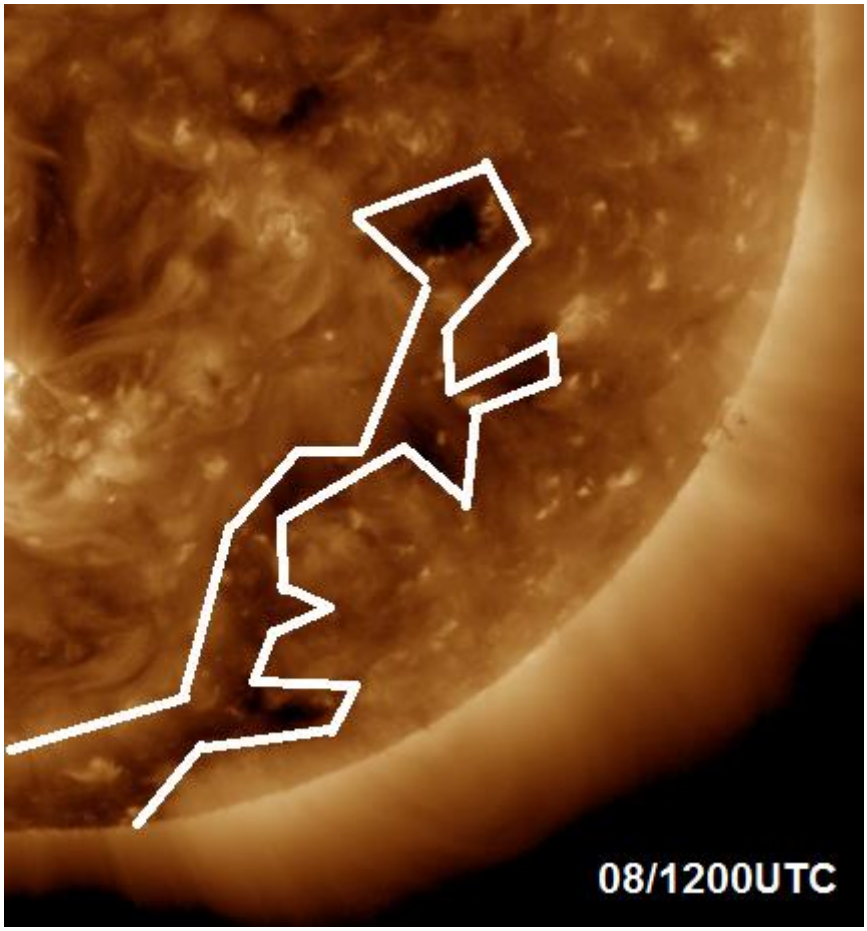
Figure 2: AIA 193 image showing the current configuration of coronal hole 43 in the southwestern quadrant. There are some tentative signs of a weak connection to the southern crown.



Radio Blackouts - X-Ray Flares:

Solar activity has remained Low in the last 24 hours, with isolated small C-class flares emanating from the larger of the two sunspot groups on the disc, AR2924. Given this spot's complexity, this is somewhat below expectations, however there is some compensation expected as a result of a congested eastern solar horizon. STEREO A EUVI imagery suggests large bright flux regions occupy both solar hemispheres, with the southern cluster probably correlating with returning regions Ex-2907 and 2908, both M-class flare-producing regions on their last pass. The northern hemisphere group is less certain, however this may be Ex-2911, which also gave an isolated M-class flare on its last outing.

At the time of writing, there was no significant upsurge in background X-ray flux or flares observed, and coronagraph imagery does not yet hint at eastern limb CMEs, however the expected course of X-ray flux is upwards over the UTC weekend. The degree to which this occurs is uncertain, however a token 20% daily risk of M-class flares is suggested until they present for analysis.

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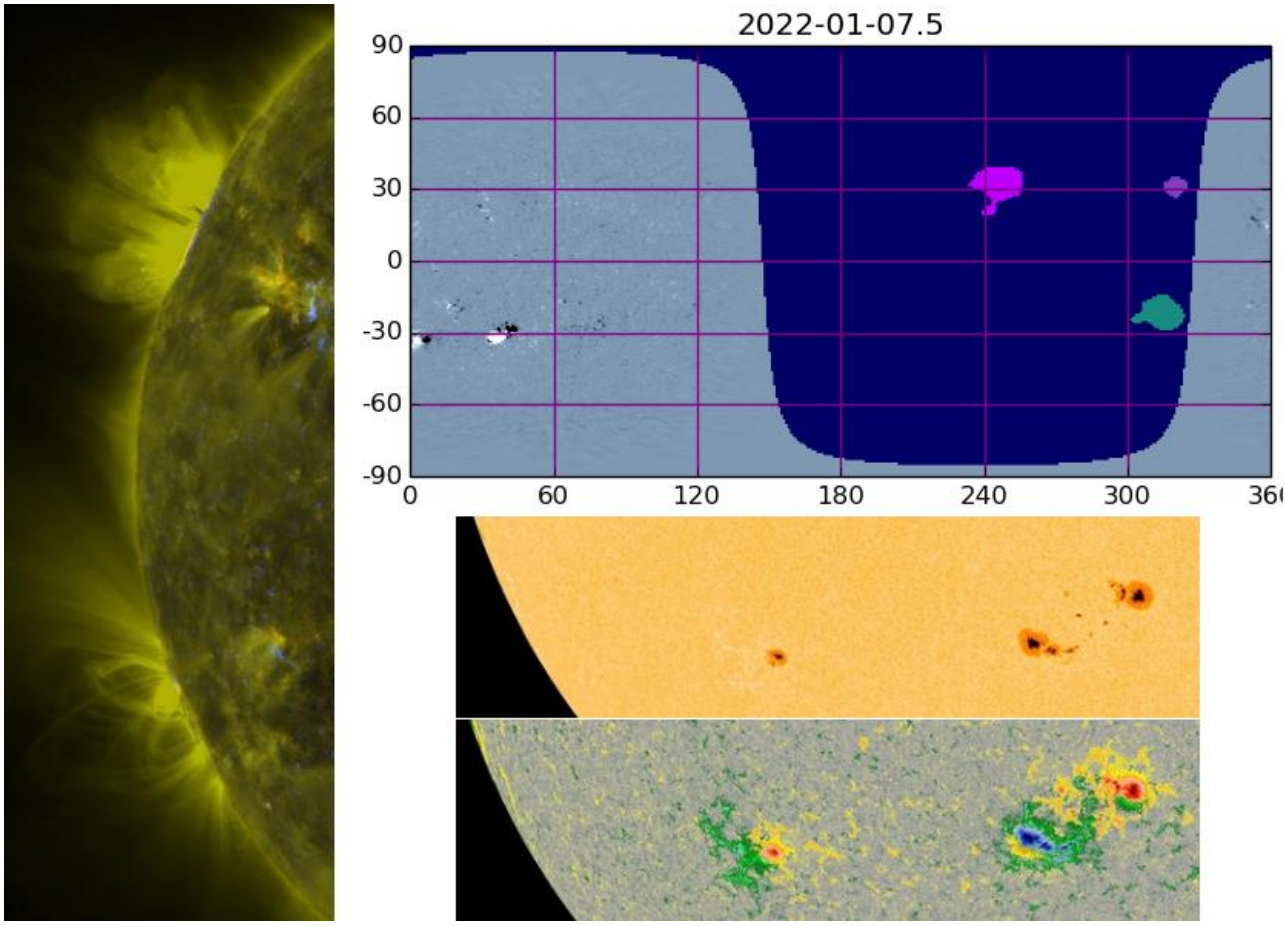
X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	15	20	20
Very Active	R3 to R5 X Class	No	1	1	2	2

Figure 3: Clockwise from top right: active region map showing soundings of the sun's far side, and in particular the regions approaching the eastern limb; HMIIF and HMIBC imagery from 08/1200UTC showing the current magnetic configurations of AR 2925 (left) and AR2924; AIA 171 and HMIBC composite image from 08/1200UTC showing bright flux from the eastern solar horizon.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at Background levels and will most likely persist at this level in the absence of solar activity. There is a slightly increasing chance of S1 as a result of westward progression of the current front sided sunspot groups.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 is currently ranging between Normal Background and Moderate levels, but diurnal peak values may approach the High threshold later on Day 1 (Saturday 08 January). The expected arrival of a high speed stream from CH43/- later on Day 1 is then likely to suppress flux levels at GEO. An eventual increase in fluence is then possible from Day 3 (Monday 10 January), although the degree to which this manifests is not certain - due to CH43 being a novel feature.

The electron fluence is most likely to remain below the Active level (1e8 integrated pfu) throughout the four days, but with an increase in risk from Day 3 onwards (Monday 10 January), with an eventual Chance of reaching the Active threshold by the end of the period.

Modelling available to MOSWOC is not felt likely to be representative in the current set-up, given the non-persistent coronal hole that dominates the geomagnetic forecast.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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